EBU **TECHNICAL**

Advice on the use of 3 Gbit/s HD-SDI interfaces

Technical Report 002

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HIPS

EBU Strategic Programme focused on the;

Harmonisation and the **I**nteroperability of HDTV **P**roduction **S**tandards

The project was a joint effort between major HDTV industry players and the EBU community to drive harmonisation and interoperability of standards related to HDTV production.

One of its areas of interest was the evolution of the HD-SDI standards and particularly, 3G-SDI. The aim of the 3G-SDI sub-group was to identify the broadcasting organisations' requirements and to supply guidance and information to new users and the industry.

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HIPS – 3G Sub Group Tasks

- To inform about Level A and B
- To determine the current use of Layer A and/or Layer B
- To determine if one of the standards meets the majority of broadcaster requirements
- To determine back compatibility requirements
- To examine the impact/timeline of 1080/p/50 production
- To examine the requirements for 3D production

HIPS – 3G Sub Group Tasks

1. Survey of members

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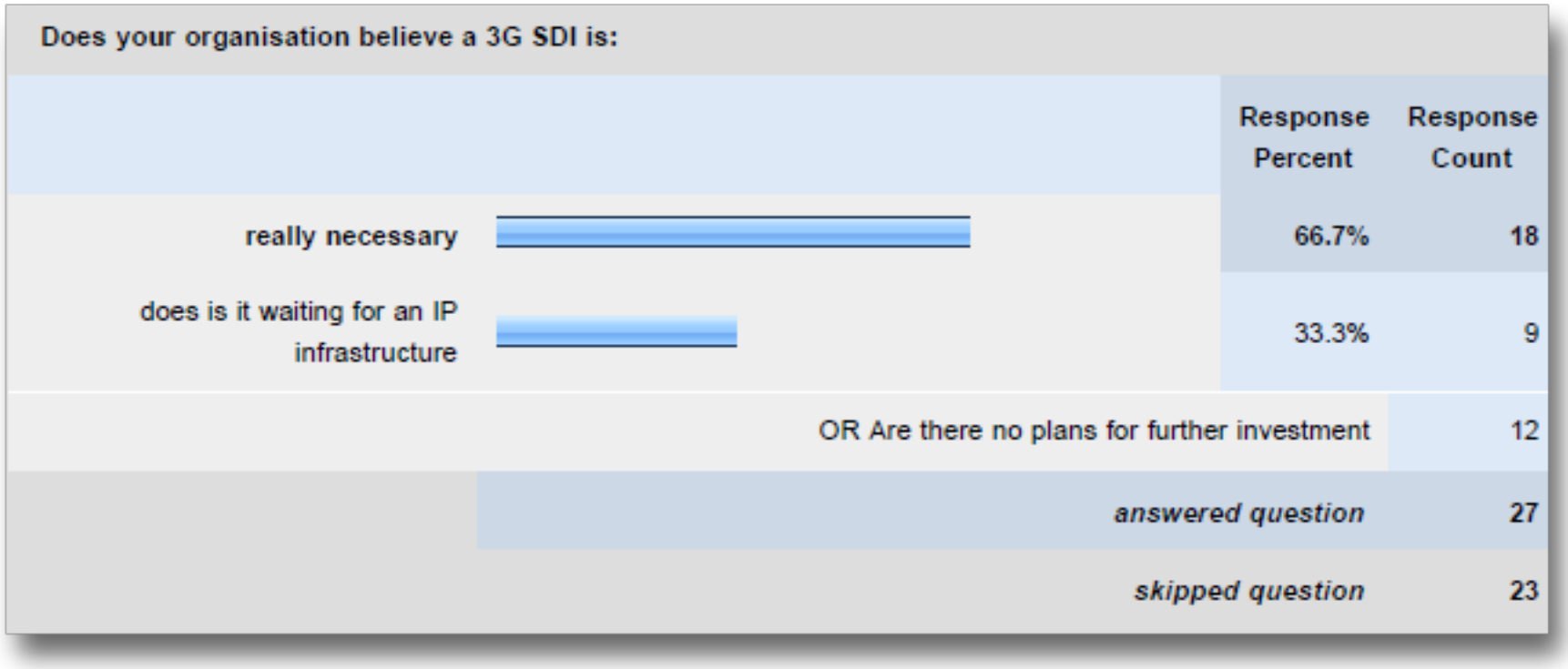

Does your organisation believe a 3G SDI is:

	Response Percent	Response Count
really necessary	66.7%	18
does is it waiting for an IP infrastructure	33.3%	9
OR Are there no plans for further investment		12
answered question		27
skipped question		23

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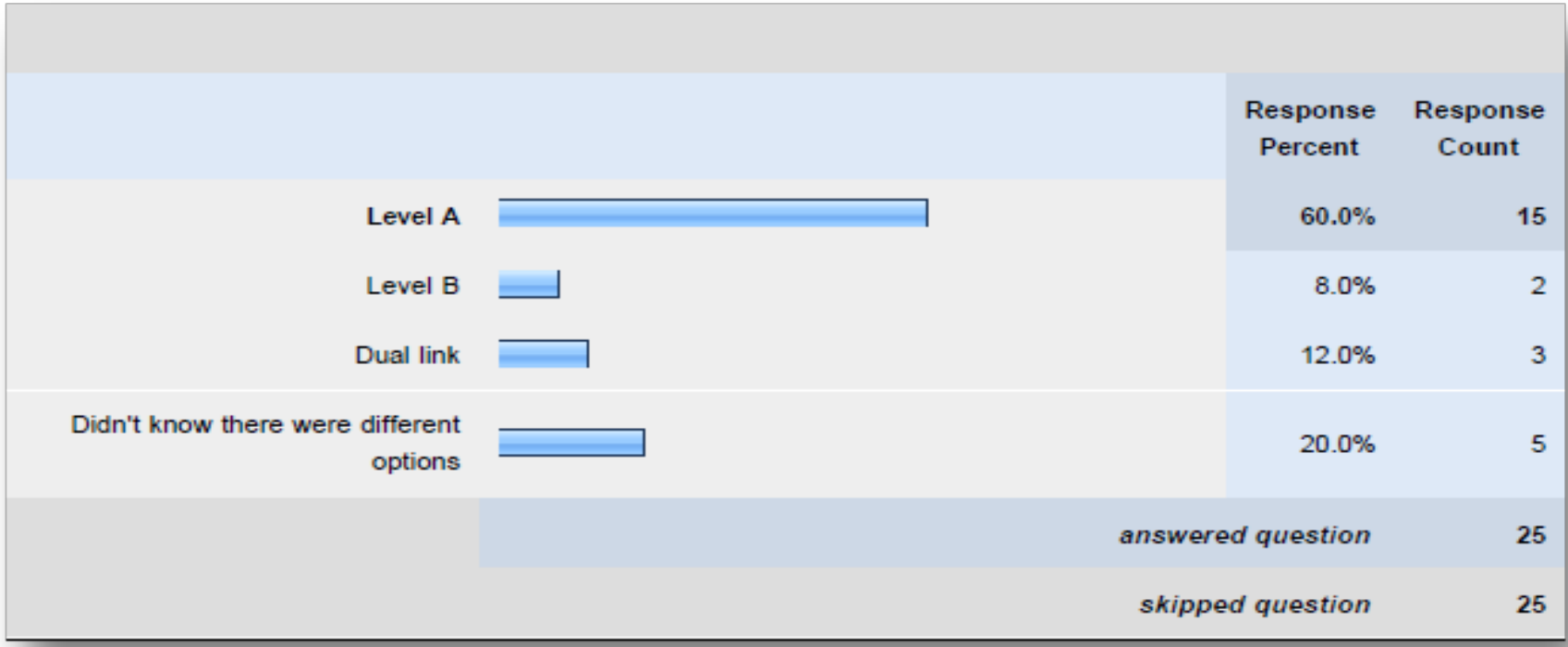

	Response Percent	Response Count
Level A	60.0%	15
Level B	8.0%	2
Dual link	12.0%	3
Didn't know there were different options	20.0%	5
answered question		25
skipped question		25

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14. 4.1. Would you like more information from the EBU

	Response Percent	Response Count
Yes	85.0%	34
No	15.0%	6
Please give details		11
answered question		40
skipped question		10

15. 4.2 If yes would you like this information to be in the form of:

	Response Percent	Response Count
EBU Tech Doc	57.1%	20
EBU Recommendation	34.3%	12
EBU Training Centre	8.6%	3
Other (Please give details)		11
answered question		35
skipped question		15

HIPS – 3G Sub Group Tasks

2. Take stock of other work

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SMPTE ROADMAP

SMPTE 425-0:2011

SMPTE Bit-Serial Interfaces at 3 Gb/s – Roadmap for the 425 Document Suite

Document Roadmap

Page 1 of 2 pages

The SMPTE 425 suite of documents defines the mapping of various source image formats onto a single link, dual link and quad link serial digital interfaces operating at a nominal rate of 3 Gb/s. This informative "roadmap" describes the documents in the SMPTE 425 suite. The SMPTE 425 series documents specify a virtual interface that is carried on a physical link specified by SMPTE ST 424.

1 SMPTE ST 425-1

SMPTE ST 425-1 defines the mapping of various source image formats onto a single link serial digital interface operating at a nominal rate of 3 Gb/s. This standard defines three mapping formats: Level A, Level B Dual-Link mapping and Level B Dual-Stream mapping as described below.

Level A specifies the direct mapping of various uncompressed video image formats and the direct mapping of packetized data into a serial digital interface operating at a nominal rate of 3 Gb/s. It also defines the carriage of ancillary data such as the audio data, the audio control packets, the payload ID, the time code, etc., for these direct mappings.

Level B Dual-Link mapping specifies the mapping of the SMPTE ST 372 Dual Link 1.5 Gb/s interface into a serial digital interface operating at a nominal rate of 3 Gb/s.

Level B Dual-Stream mapping specifies the mapping of two of the SMPTE ST 292-1 1.5 Gb/s HD-SDI interfaces into a serial digital interface operating at a nominal rate of 3 Gb/s.

Uncompressed video image formats or packetized data, and all applicable ancillary data such as the audio data, the audio control packets, the payload ID, the time code, etc., shall be mapped into SMPTE ST 372 Dual Link and 2 x SMPTE ST 292-1 interfaces prior to mapping into the virtual interfaces.

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Approved
March 30, 2011

SMPTE 425-0:2011

"SMPTE Bit-Serial Interfaces at 3Gb/s – Roadmap for the 425 Document Suite"

SMPTE ST 425-1:2011

"Source Format and Ancillary Data Mapping for the 3Gb/s Serial Interface"

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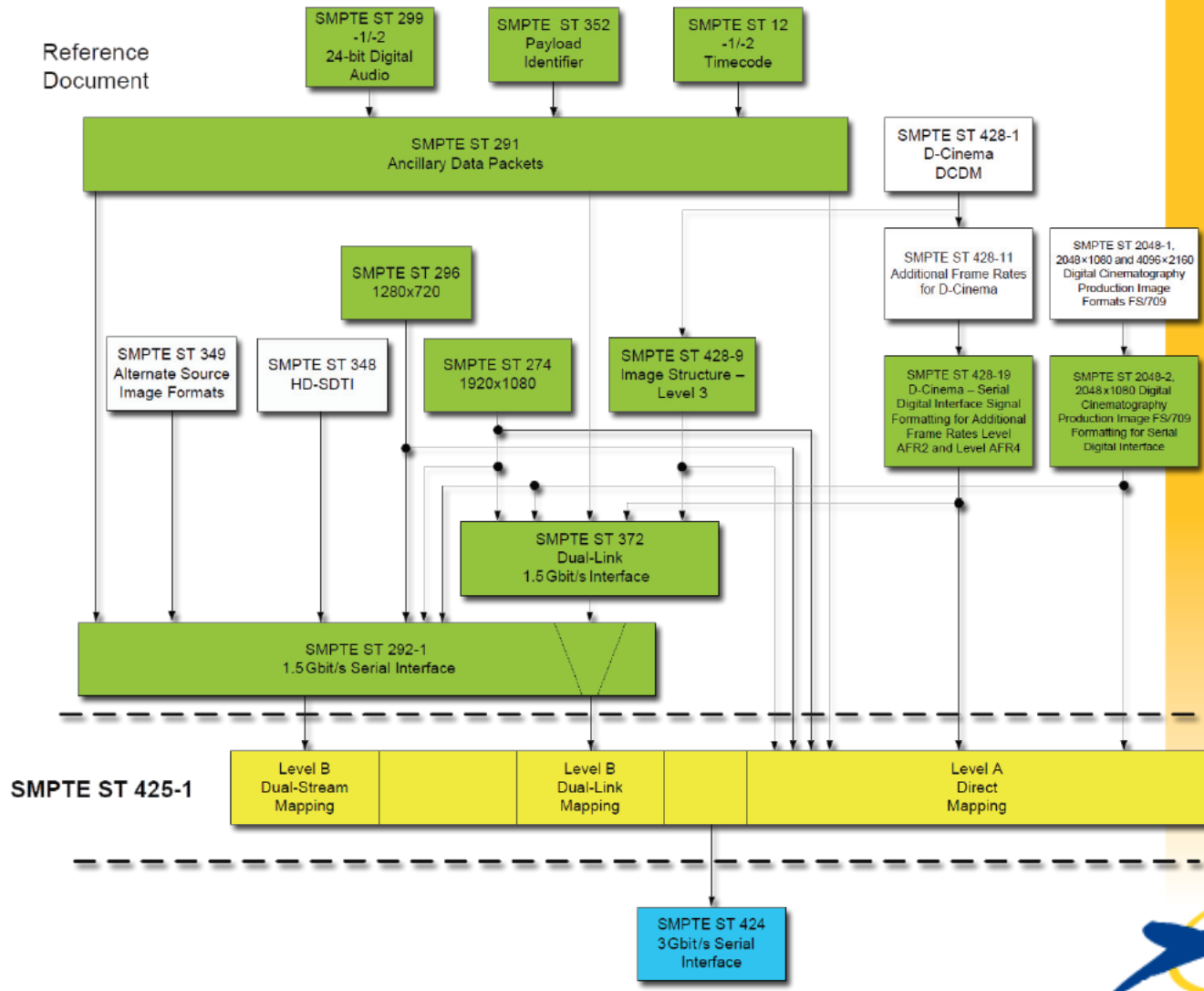
Antecedence

SMPTE ST 425-1 2011 has evolved from the many documents describing the HD Serial Digital Interface

SMPTE 425 Document Suite



HIPS – 3G Sub Group Tasks

3. Delivery

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Scope

To give technical guidance to members who are planning or considering 3G SDI installations

1. The 3G-SDI interface is required primarily to deliver 1080p/50 (or 59.94) over a single link.
2. Recently it has also been used by some organisations to transport twin 1.5G-SDI signals for Stereoscopic 3DTV.
3. An EBU Technical Report, ***not*** a recommendation. The choice of 3 Gbit/s infrastructure must be based on the requirements of the business

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What is Tech 002

Guidance and Information based on SMPTE ST 425-1:2011

- Background to SDI
- Overview of the 3Gb/s SDI mapping
- Information
- Installation and Measurement
- Detail of the 3Gb/s mappings

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The Serial Digital Interface

Wikipedia

Serial digital interface (SDI) is a family of video interfaces standardized by SMPTE. For example, ITU-R BT.656 and SMPTE 259M define digital video interfaces used for broadcast-grade video. A related standard, known as high-definition serial digital interface (HD-SDI), is standardized in SMPTE 292M; this provides a nominal data rate of 1.485 Gbit/s.

…A more recent interface, 3G-SDI, consisting of a single 2.970 Gbit/s serial link, is standardized in SMPTE 424M that will replace the dual link HD-SDI

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The Serial Digital Interface

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A digital signal can be transmitted by many different methods, but the generally accepted format in professional television is the Serial Digital Interface (SDI)

The SDI is an 800 mV binary serial digital signal but it must be remembered that the actual digital signal is an **analogue** representation of the digitised image, and is therefore subject to the problems of any analogue system.

The challenge is to tell the difference between the two binary values at the destination with sufficient accuracy to recover all of the numbers correctly.

As the number of bit per second goes up, the bigger this challenge becomes.

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What is 3G SDI mapping?

The SMPTE has described three different mapping schemes for transporting uncompressed video, ancillary data such as the audio data, the audio control packets, the payload ID, the time code, etc. into a serial digital interface operating at a nominal rate of 3 Gbit/s.
These are defined as Level A, Level B Dual Link (B-DL) and Level B Dual Stream (B-DS).

Level A Is the direct mapping of an uncompressed 1080p/50 video stream into a serial digital interface operating at a nominal rate of 3 Gbit/s.

Level B-DL Is the dual-link mapping of a 1080p/50 video stream into a serial digital interface operating at a nominal rate of 3 Gbit/s.

Level B-DS Is the dual-stream mapping of two independent 1080i/25 (or 1080p/25) video streams into a single serial digital interface operating at a nominal rate of 3 Gbit/s.

3G SDI Information

Overview

Level A and **Level B-DL** support 1080p/50 and the design will be more robust if one format (Level A or Level B-DL) is used throughout

Level B-DS carries two 1.5G-SDI streams on a single coax cable and while the ITU and SMPTE are discussing standards, Level B-DS is being used by some organisations to carry the left and right eye signals of stereoscopic 3DTV.

Although Level B-DL carries 1.5Gb/s signals it is subject to the same 3Gb/s installation requirements as Level A and Level B-DL.

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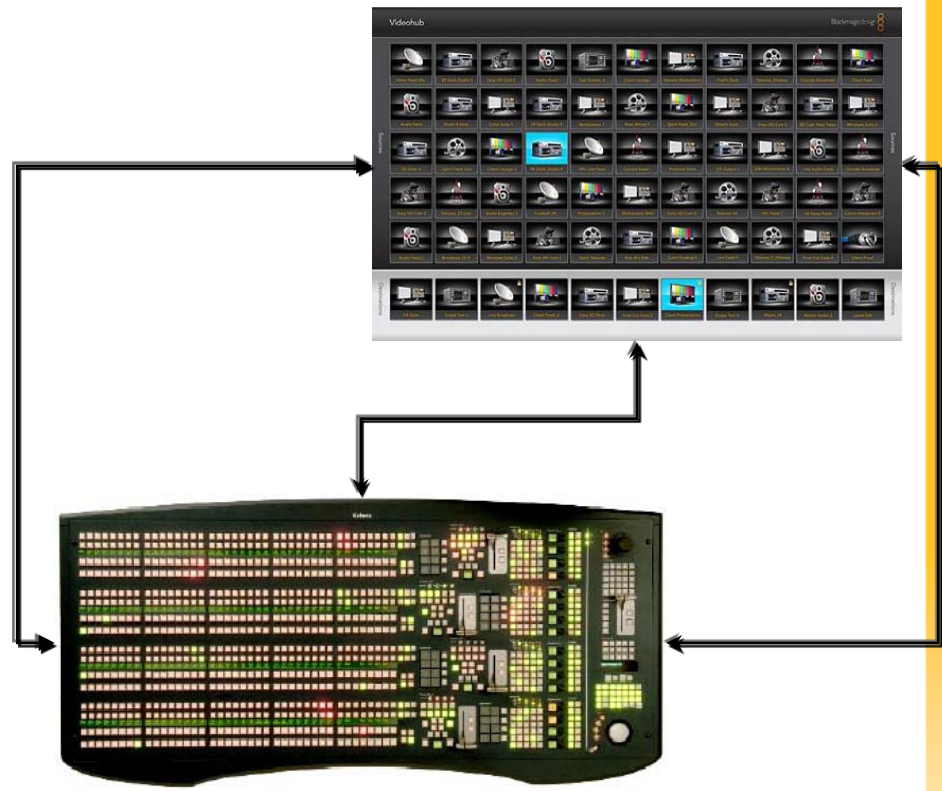
3G SDI Information

Conversion Delay

Conversion between Level A and Level B-DL introduces a delay of at least one video line.

These delays can concatenate in installations with a mix of Level A and Level B-DL plant if it is not compensated for.

This is very important around vision mixers and routers where signals may pass through many times often via other external devices, during processing such as compositing.



3G SDI Information

Conversion Delay

Conversion of signals with embedded audio or other ancillary data may increase the delay and introduce additional complexity to correct the positioning or timing of some ancillary data packets.

Some devices process signals internally using a different standard to their own input/output standard. It always advisable to confirm these devices compensate for any conversion delay internally before installation.

3G SDI Information

Pathological Test Patterns

Level A and both Level B mappings require different pathological test patterns to make sure the interface is correctly stressed.

Level A - Bit-Serial Digital Check-Field pattern as defined in SMPTE RP198 is applicable.

Level B - The SMPTE is revising SMPTE RP 198 to include specific 3 Gbit/s pathological test patterns for Level B-DL and Level B-DS.

3G SDI Information

Switch Regions

For 1080p/50, Level A, B-DL and B-DS serial streams use switching point defined in SMPTE RP 168:2009.

WARNING: There is no requirement for frame alignment of each image carried on the link in Level B-DS .

Remember: If the two images are not frame aligned, video switching could be adversely affected. It is always recommended the two signals should be frame alignment in Level B-DS interfaces.

3G SDI Issues

Payload Mapping

The use of the SMPTE ST 352 Payload ID is *mandatory* due to the large number of different video formats that can be carried in the 3 Gbit/s interface,

Without the payload ID, it is not possible to correctly identify all of the supported formats or mapping modes purely from inspection of the payload data

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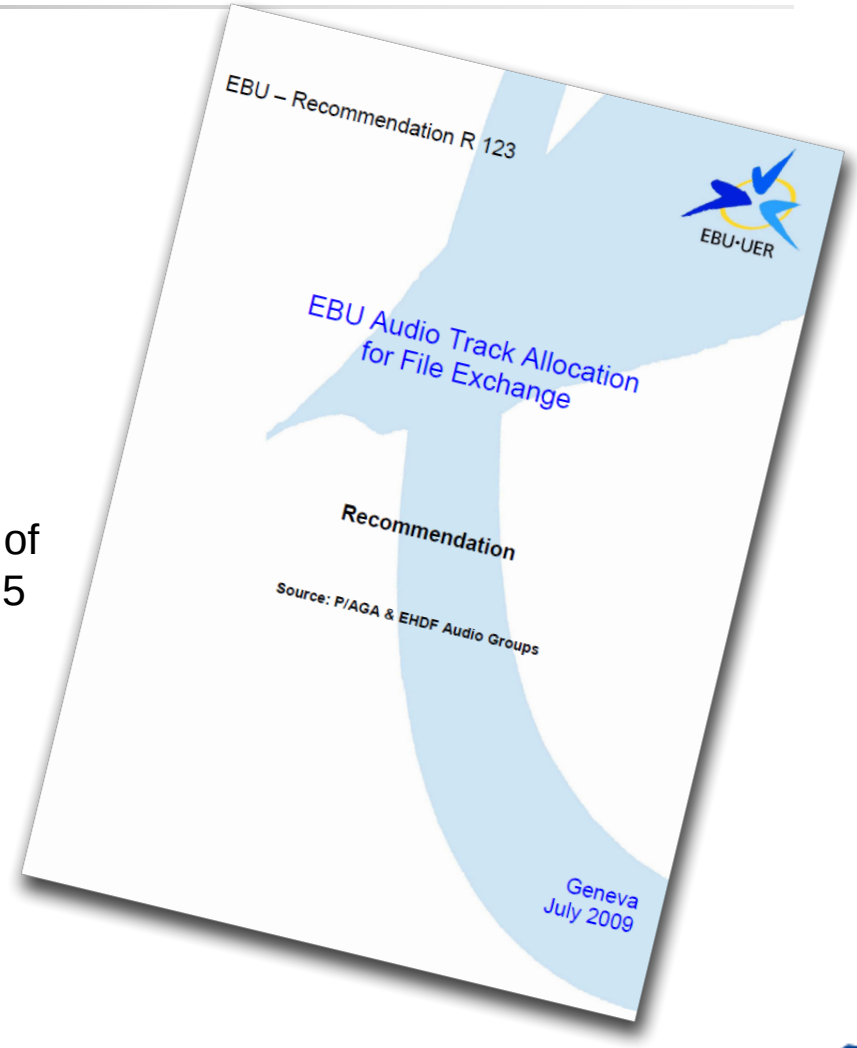
3G SDI Issues

Embedded Audio

Level A, B-DL and B-DS can carry up to 32 audio channels.

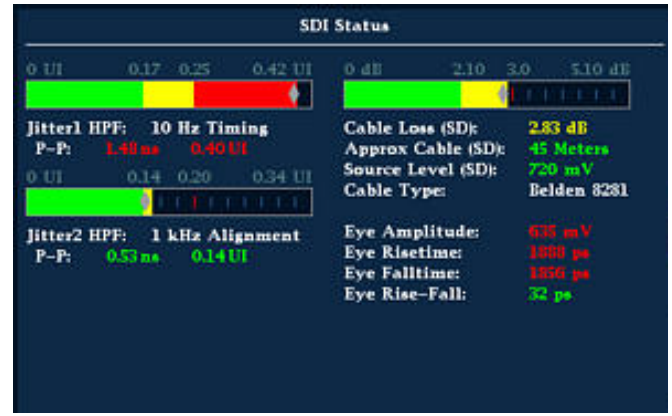
Level B-DS carries the 32 channels as two groups of 16, (that is 16 audio channels on each of the two 1.5 Gbit/s streams

Audio track allocation is defined in EBU R 123



3G Installation and Measurement

The quality of the digital serial data signal can be represented in an eye-diagram. The eye-diagram is an analogue view in the physical layer of the HD (or SD) SDI Signal.



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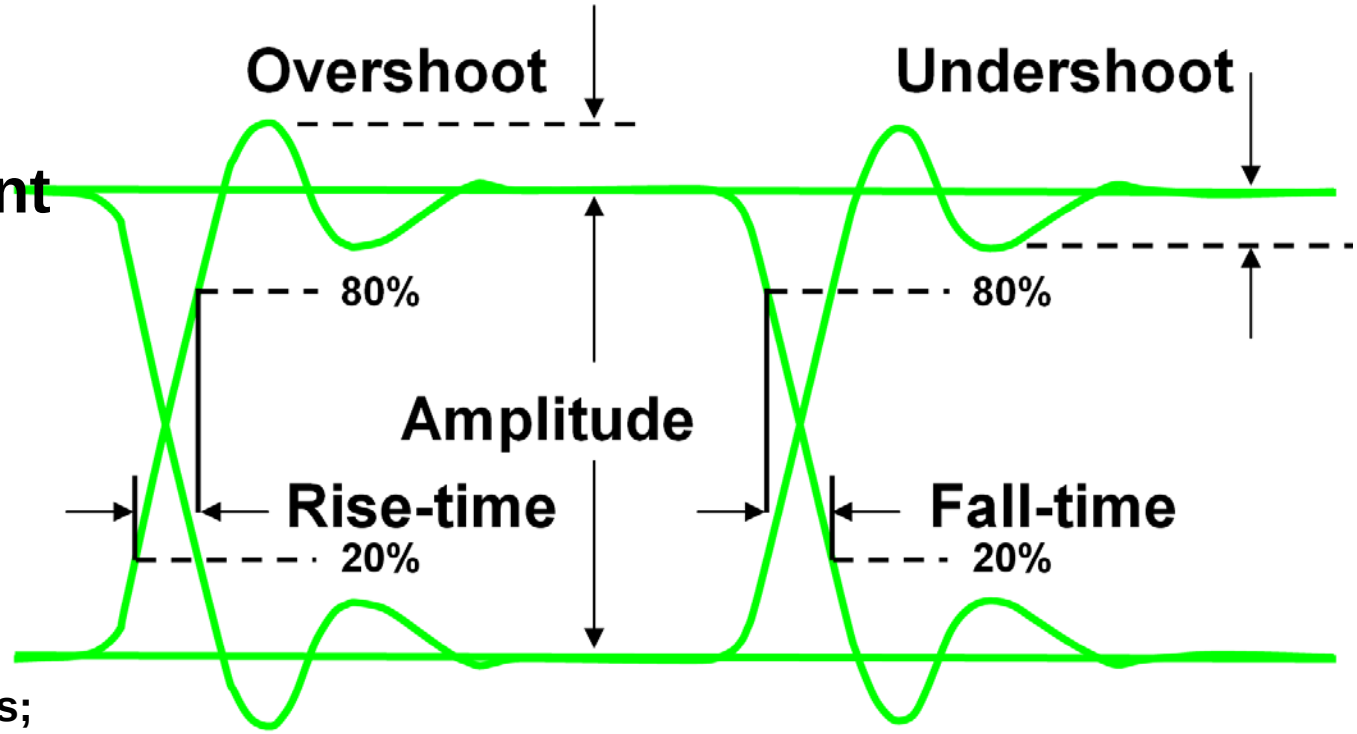
3G Measurement



The eye-diagram shows;

- Amplitude - 800mV (10%)
- Rise and fall-time - Not grater than 135ps
- Over and under-shoot - Not to exceed 10% amplitude
- Duration of one unit interval - 336.7ps

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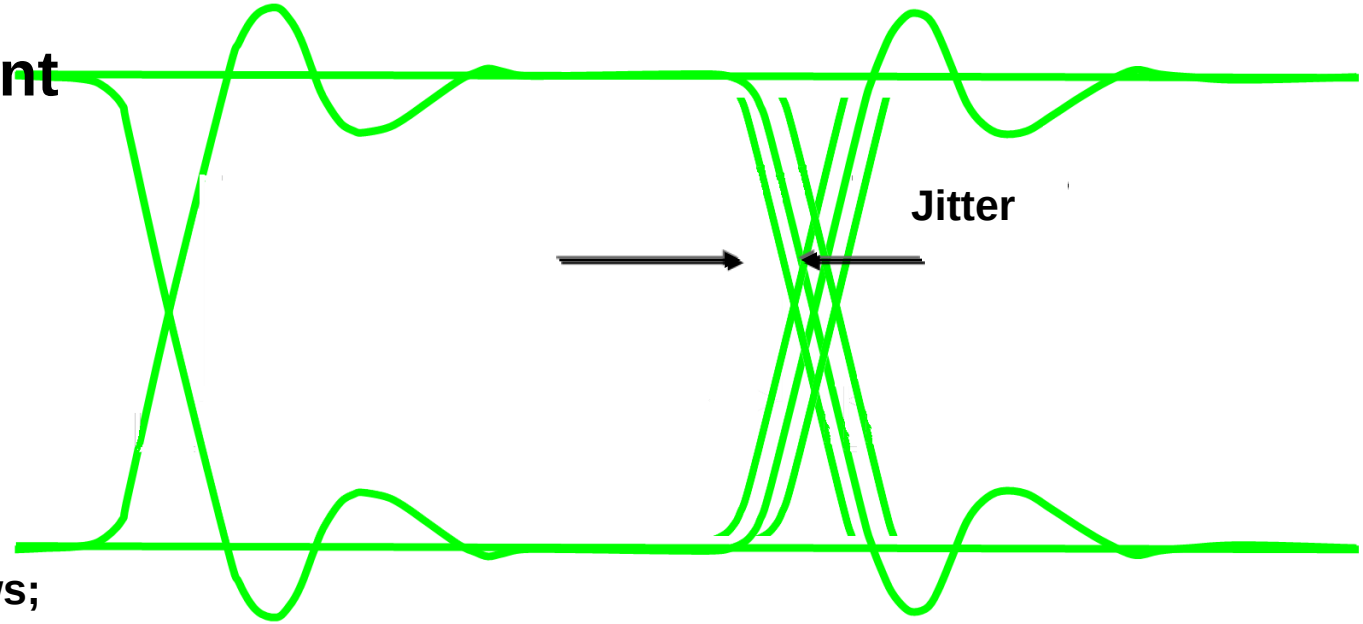
3G Measurement



The eye-diagram shows;

If the analyser is DC-coupled, the DC-offset can be shown.
It is possible to measure jitter (ITU-R BT.1363 and SMPTE RP 184**)**

Timing Jitter <= 2UI above 10Hz
Alignment Jitter <= 0.3UI above 100kHz

If detailed jitter information is needed, a jitter waveform-diagram should be used.

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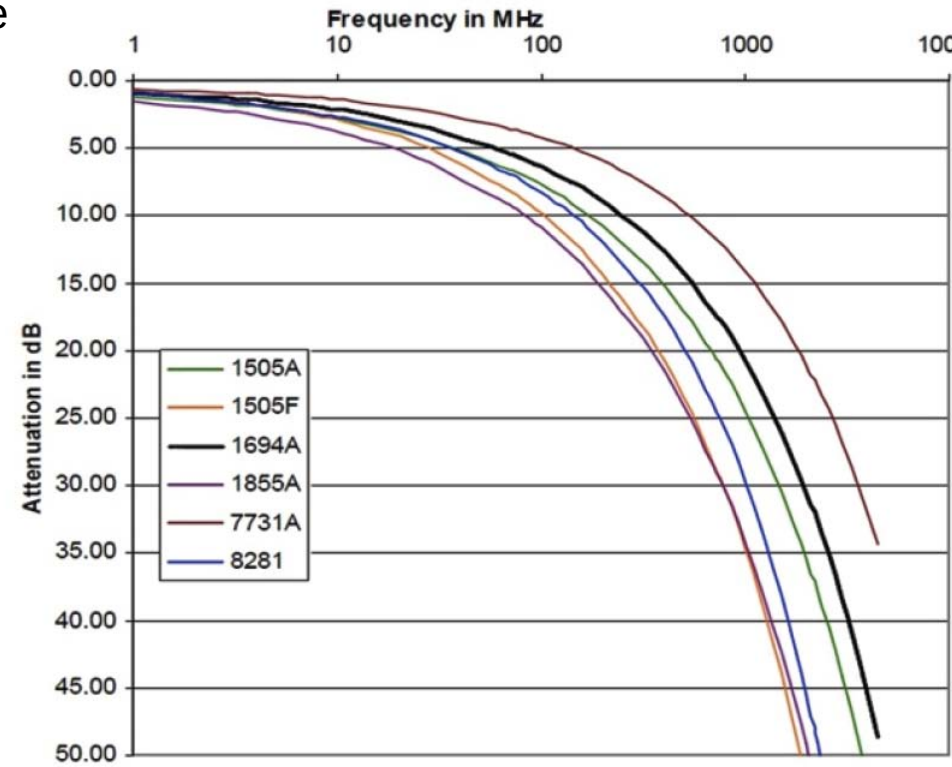
3G Measurement

Return Loss: Return Loss (RL) is a measure of the impedance of an interface. The higher the measured value of return loss in an interface, the better is the impedance of the interface to the infrastructure

Quality of an SDI input: At 3 Gbit/s, cable losses increase by 40%, connector discontinuities become twice as significant, the signal bandwidth doubles, the crosstalk potential increases and amplifier gain is harder to achieve at the higher bandwidth.

Cable length, Type & Equalisation: Examples and measurements by NRK



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Transm. loss(dB)/100m	Belden 1694	Belden 1505	Belden 1855	Draka 0.6/2.8	Draka 1.0/4.8	Bedea 0.6/2.8	NEK 0.6/2.8	Draka HD Pro; 1.0/4.8
@ 742.5MHz	-17.67	-22.09	-27.9	-30.05	-19.35	-30.73	-28.96	-18.7
@ 1485MHz	-25.11	-31.36	-39.73	-42.94	-27.82	-43.85	-41.17	-26.7
@ 2970MHz	-36.2	-45.32	-57.62	-62.55	-40.35	-63.6	-58.93	-38.4
Structural return Loss (SLR)	-29.12	-29.44	-28.23	-28.08	-28.57	-14.9	-35.05	-29.4
Connector impedance matching (RL in dB)								
/Amphenol 1	-33.38							
/Amphenol 2	-34.53							
/Canare 1	-29.65							
/Canare 2	-30.28							
/D&H (1)	-19.86							(D&H 1-6054) -25.0
/D&H (2)	-20.56	-30.28	-26.21					(D&H 1-6054) -25.9
/D&H 1 (1)		-30.28	-26.21					(D&H 1-6054) -26.1
/D&H 1 (2)		-30.4	-28.64					(D&H 1-6054) -25.7
/D&H 2 (1)		-32.56	-27.28					
/D&H 2 (2)		-32.05	-27.25					
/D&H II (1)	-20.94							
/D&H II (2)	-19.8							
/Neutrik 1	-31.26							
/Neutrik 2	-29.01							
/Suhner 1		-29.4			-33.4			
/Telegartner 1	-29.81							
/Telegartner 2	-30.67							
/Suhner				-34.4				
/D&H 1-6769				30				

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3G Measurement examples

Cable Length: Amplitude loss, frequency loss, Rise and fall time increase

Termination: Under and Over Shoot increase.

Rise and Fall timing: *Eye cross point shifts*

Tektronix

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Practical Cable Installation guidelines

- Reduce “cable sag” and minimise signal reflections that can increase losses.
- The use of Velcro® strips instead of tie-wraps minimise distortions in the dielectric.
- Cable run planning to minimise cable lengths
- Monitoring the consistency and quality of cable cutting and stripping and connectors.
- Avoid patch panels but where required good connector quality is vital.
- The long-term performance of jackfields must be monitored.
- The choice between fibre and copper is about quality and consistency not just cost and cable length

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TR 002 Annex

A - Level A

B - Level B-DL

C - Level B-DS

1. Overview
2. Mapping
3. Virtual Interface
4. Alpha Channel
5. Audio
6. Payload ID

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With many thanks to

- **Grass Valley** – Bob Edge
- **Sony** – Allan Arthurs Hiroshi Nakano
- **Panasonic** – Stefan Hofman
- **Gennum** – John Hudson Nigel Seth-Smith
- **IRT** - Friedrich Gierlinger
- **EBU** - Adi Kouadio

And many others from member organisations and manufacturers and interested parties

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Thank you